

A Decision Support System for the Yakima River Basin

Developed as part of the
Watershed and River Systems
Management Program (WaRSMP)

Mark Mastin
John Vaccaro

Chris Lynch
Warren Sharp



Why is a Decision Support System important?

- Many water issues exist in a basin and interact in a complex fashion
- A solution for one issue may create new issues elsewhere
- Water management requires looking at issues at different time scales in both the past and future

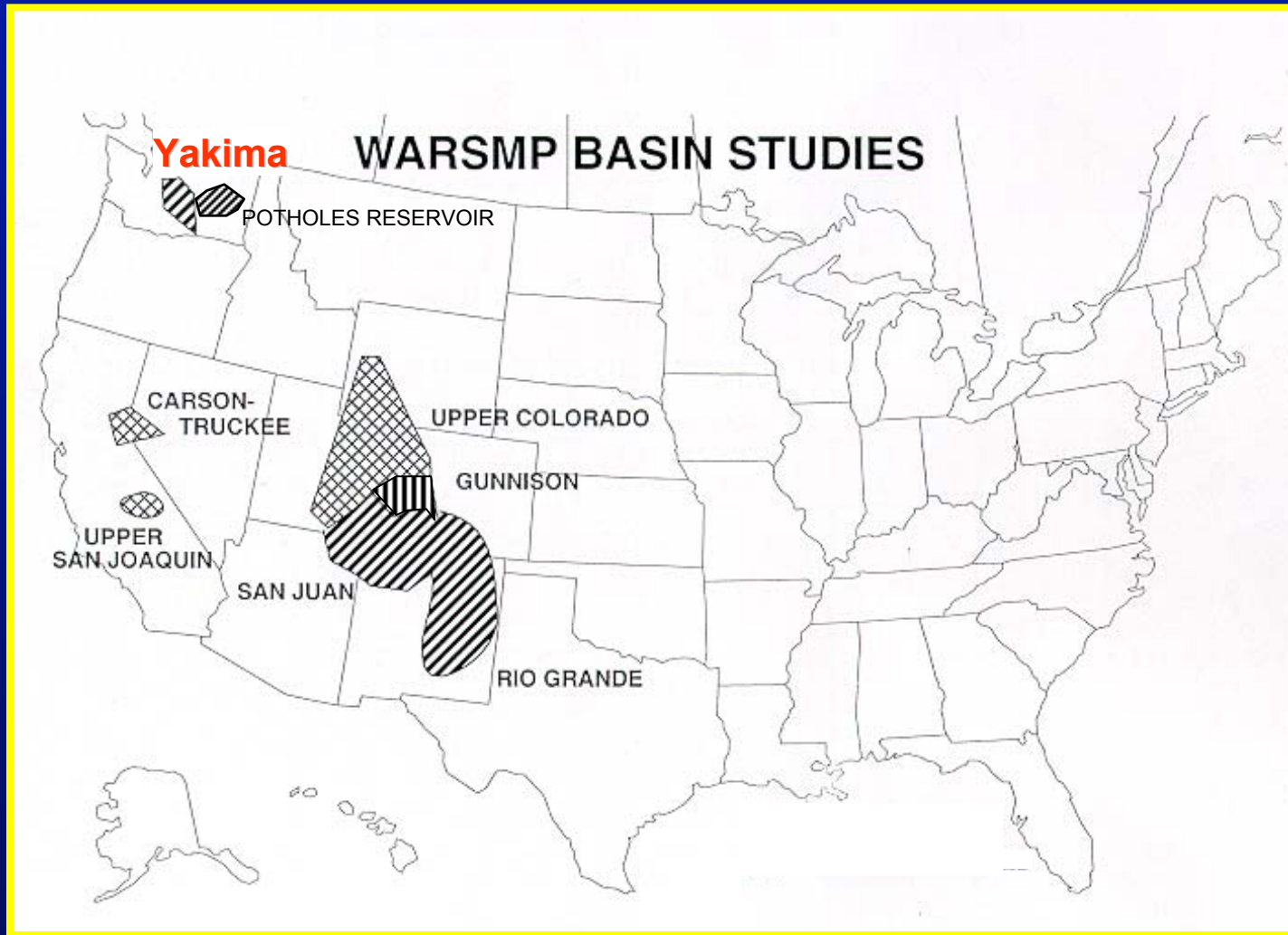
Outline for this talk

- Watershed and River Systems Management Program (WaRSMP)
- Decision Support Components
- Description of Yakima River Basin
- MMS and the Yakima River Basin watershed models

Watershed and River System Management Program (WARSMP)

- Cooperative USGS / USBR
- Purpose is research, development, and implementation of a DSS to achieve equitable balance among water resource issues.

WaRSMP Basin Studies

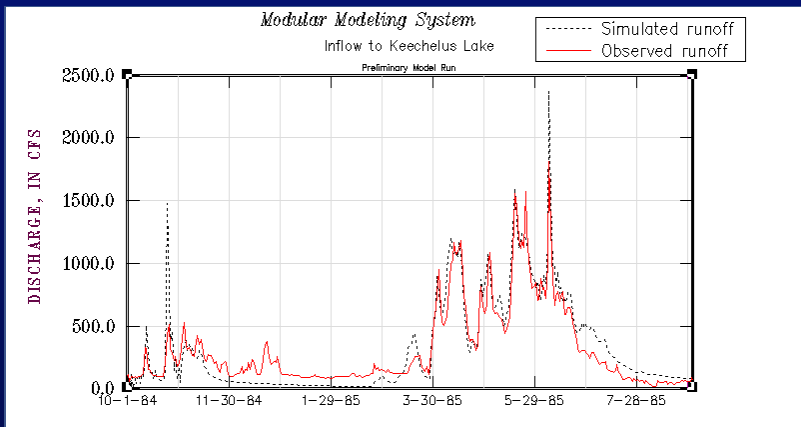


River Management Issues in the Yakima Basin



Management

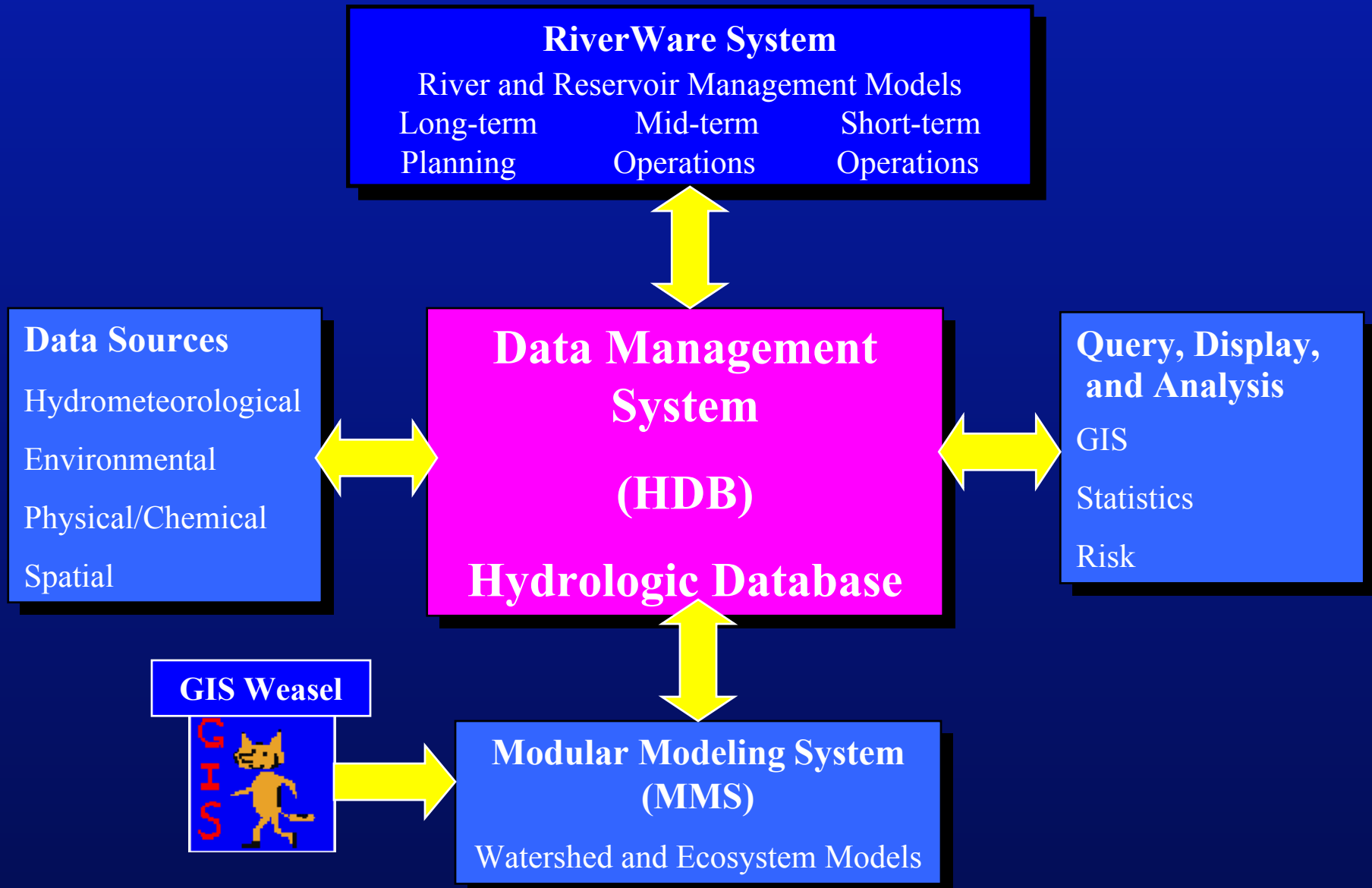
- Optimize power, storage, irrigation, and recreation
- Water rights
- Irrigation return flows and salinity
- Habitat for anadromous fish



Modeling

- Improve runoff volume forecasting
- Improve modeling of ground-water/surface-water interactions

Database-centered Decision Support System



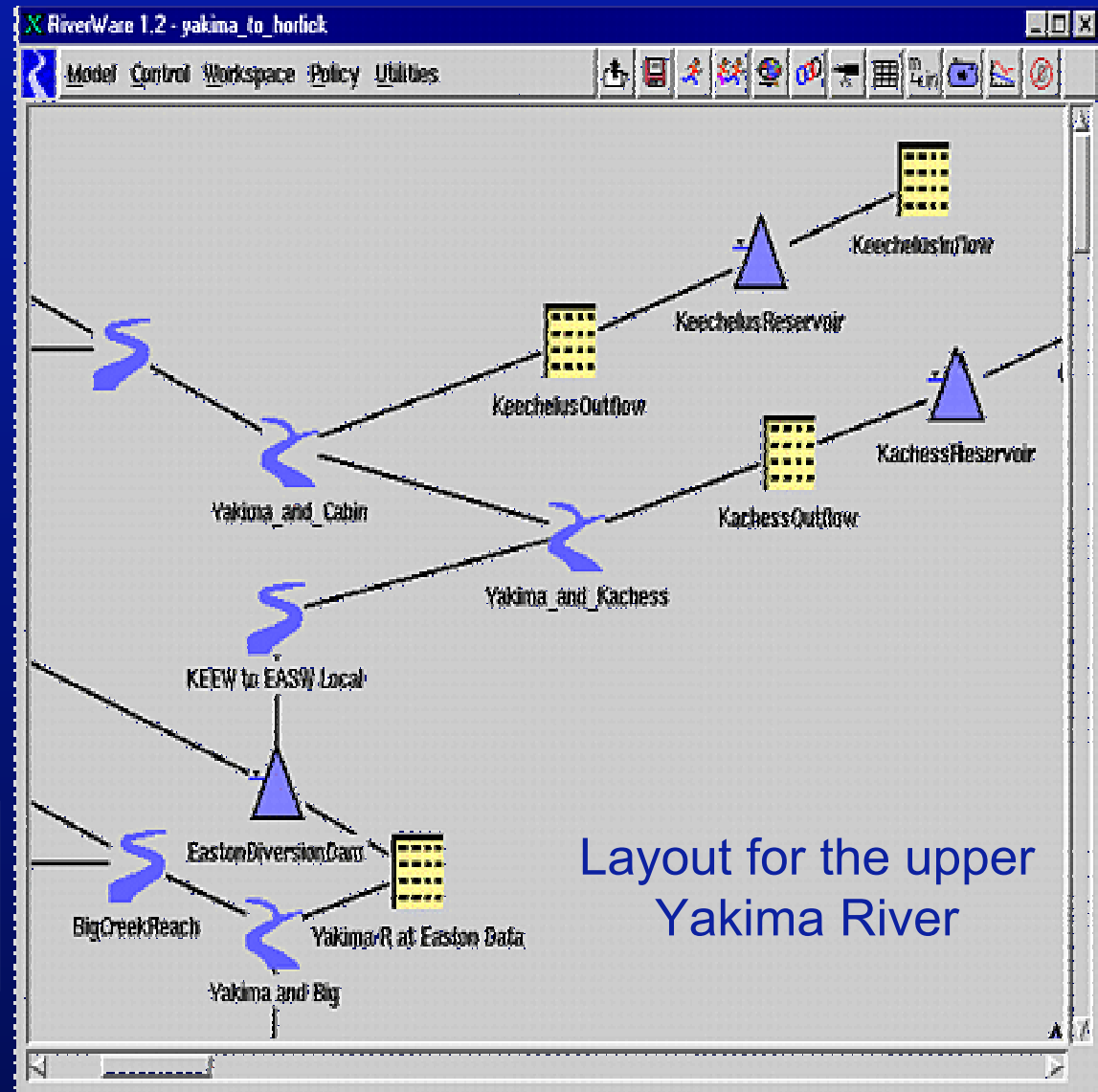
RiverWare--a Water-Distribution Model

RiverWare uses
object-oriented
modeling.



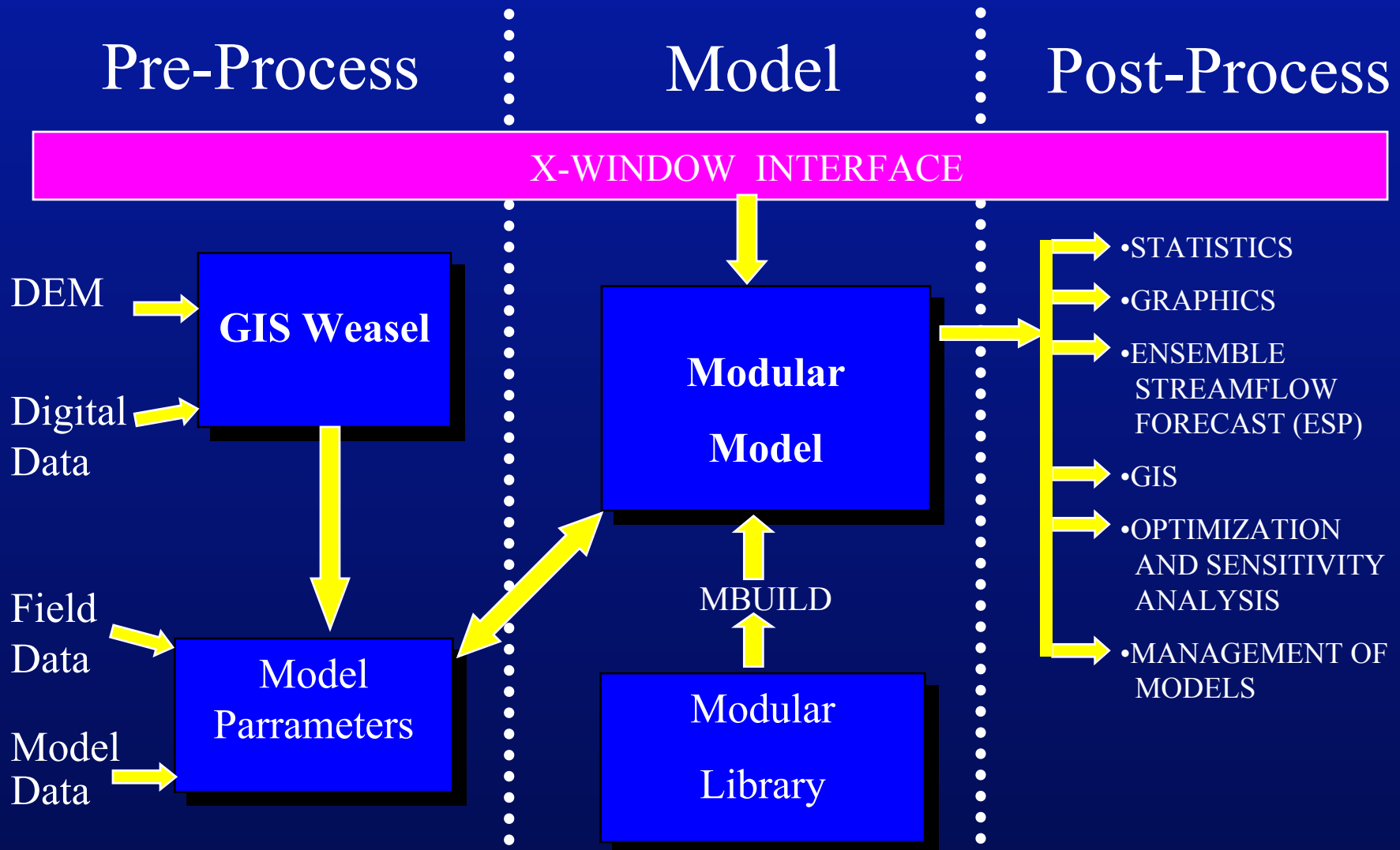
The Center for Advanced Decision Support for Water and Environmental Systems
The Department of Civil, Environmental and Architectural Engineering
College of Engineering and Applied Science

The University of Colorado at Boulder



Layout for the upper
Yakima River

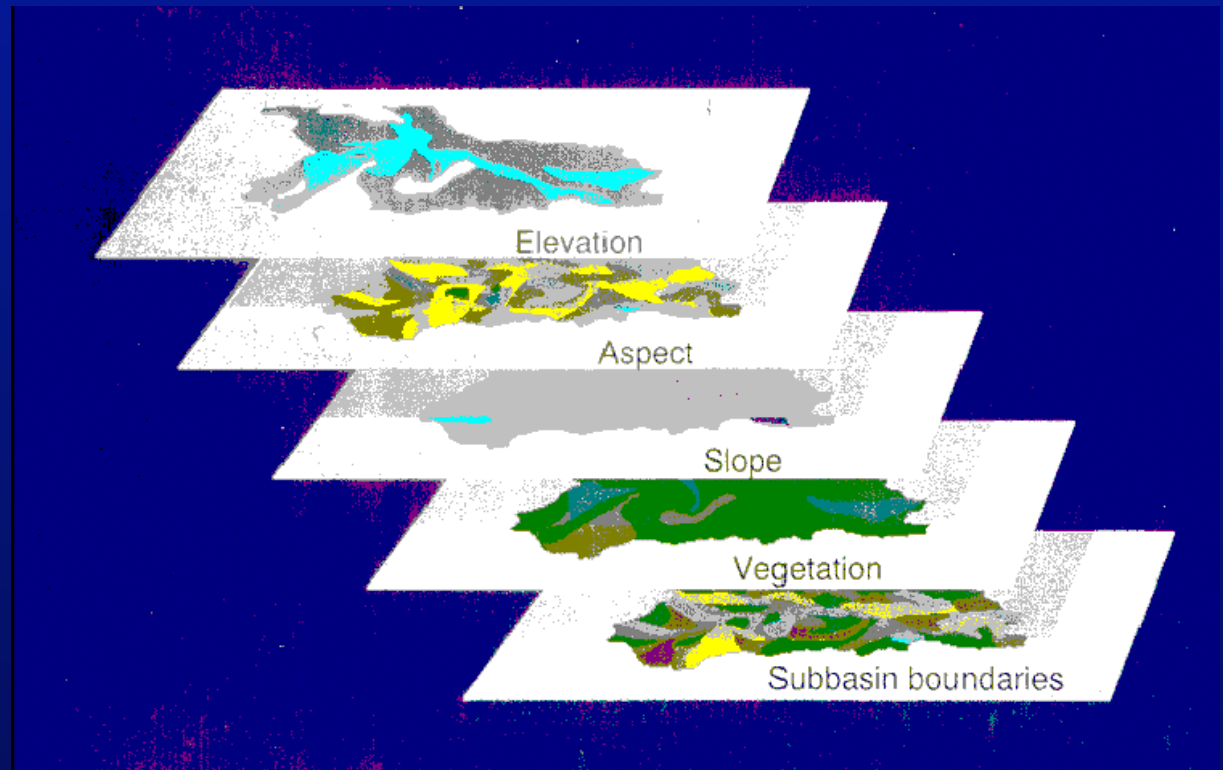
Modular Modeling System (MMS) Components



The GIS Weasel

Thematic data used to directly compute model parameters

- Topography
- Soils
- Vegetation
- Land Use

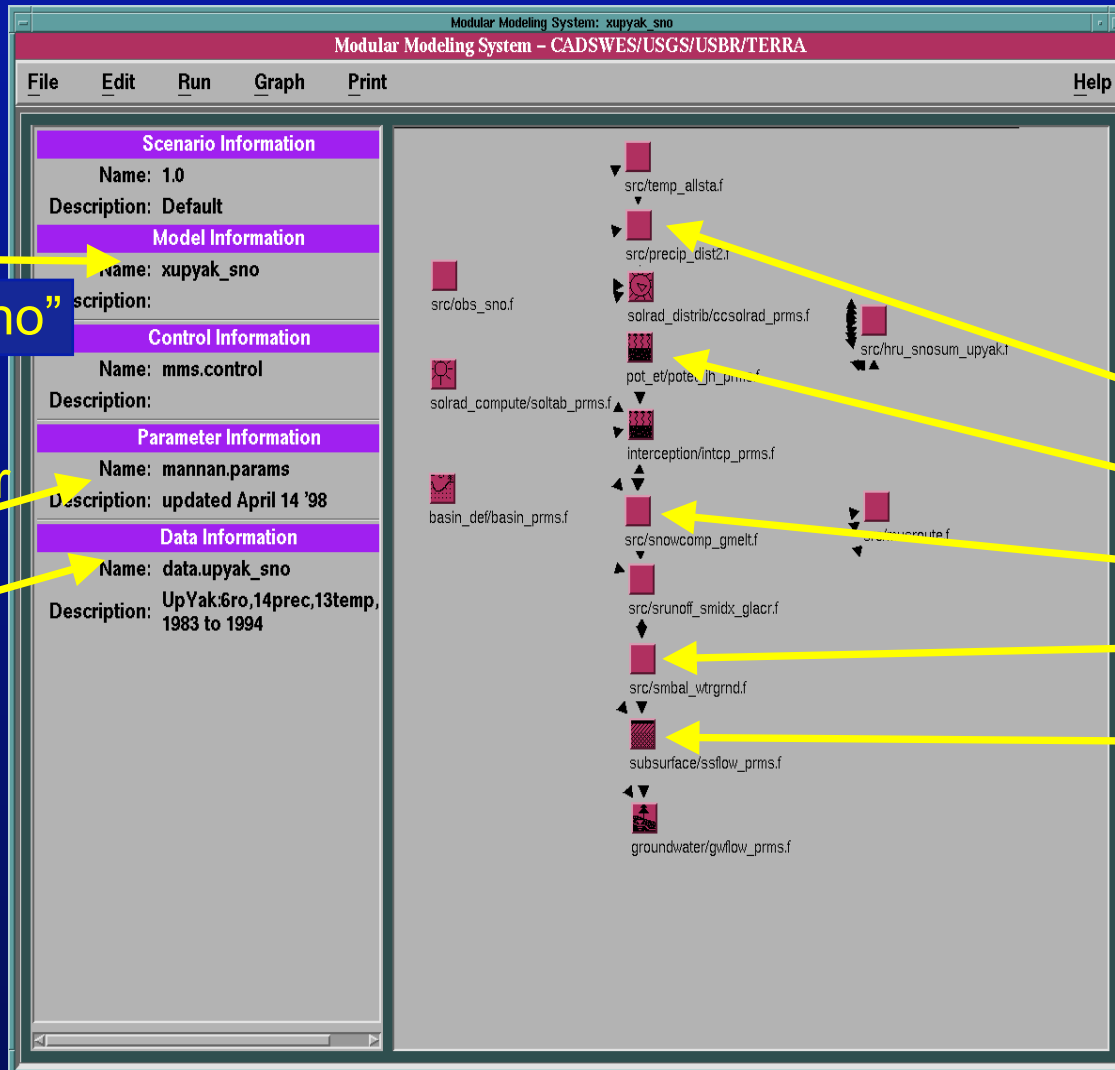


MMS--Building a Custom Watershed Model

•Model
“xupyak_sno”

•Parameter
File

•Data File



Select Modules from
Module Library:

- Precip. distribution
- Evapotranspiration
- Snowmelt
- Soil moisture
- Runoff
- Many more!

MMS--Spreadsheet of Model Parameters

Modular Modeling System: xupyak_sno

Modular Modeling System - CADSWES/USGS/USBR/TERRA

File Edit Run Graph Print Help

Array Spreadsheet Editor - nhru

Editor Functions

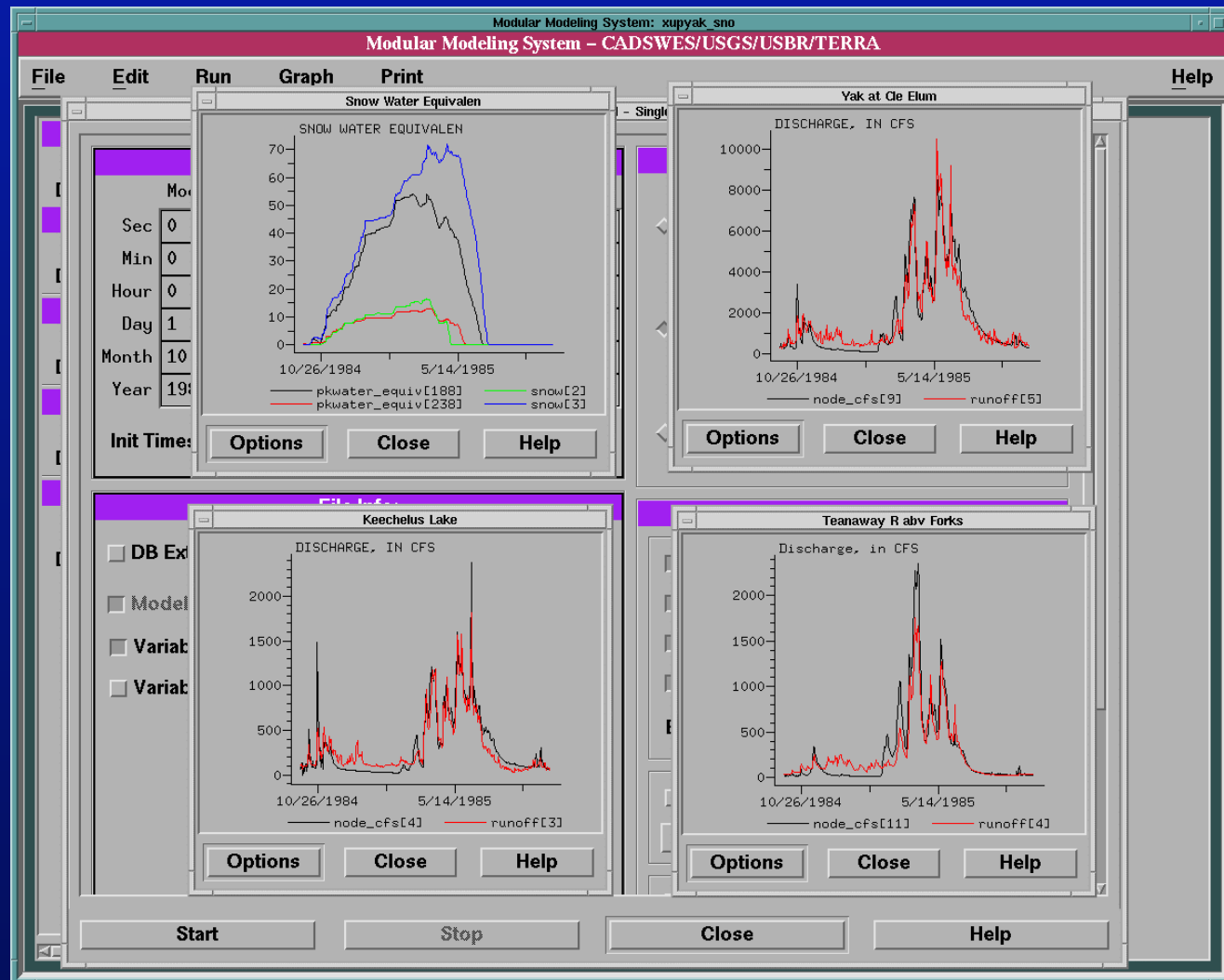
- Copy
- Multiply
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- Cut
- Paste
- Undo
- Import
- Export
- Annotate

	srn	intc	intc	intc	srn	srn	basi	snow	basi	gwfl	musr	basi
	care	cov_	covd	covd	glac	glac	hru_	hru_	hru_	hru_	hru_	hru_
1	0.60	3	0.99	0.99	0	0.00	581.	1	3676	1	1	0.00
2	0.60	3	0.83	0.83	0	0.00	635.	1	4502	1	1	0.00
3	0.60	3	0.89	0.89	0	0.00	2035	1	4083	1	1	0.00
4	0.60	3	1.00	1.00	0	0.00	150.	1	3212	1	1	0.00
5	0.60	3	0.98	0.98	0	0.00	1066	1	4499	1	1	0.00
6	0.60	3	0.96	0.96	0	0.00	1221	1	4304	1	1	0.00
7	0.60	3	0.98	0.98	0	0.00	227.	1	4568	1	1	0.00
8	0.60	3	1.00	1.00	0	0.00	222.	1	4509	1	1	0.00
9	0.60	3	1.00	1.00	0	0.00	930.	1	4161	1	1	0.00
10	0.60	3	1.00	1.00	0	0.00	2330	1	4055	1	1	0.00
11	0.60	3	0.89	0.89	0	0.00	243.	1	5113	1	1	0.00
12	0.60	3	0.94	0.94	0	0.00	523.	1	5362	1	1	0.00
13	0.60	3	0.96	0.96	0	0.00	307.	1	5084	1	1	0.00
14	0.60	3	1.00	1.00	0	0.00	1020	1	2863	1	1	0.00
15	0.60	3	1.00	1.00	0	0.00	822.	1	2874	1	1	0.00
16	0.60	3	1.00	1.00	0	0.00	1262	1	4543	1	1	0.00
17	0.60	3	0.92	0.92	0	0.00	1390	1	3868	1	1	0.00

OK Cancel Help

>54,000
parameters in
the Upper
Yakima model.

MMS--Realtime Graphics



Yakima River Basin

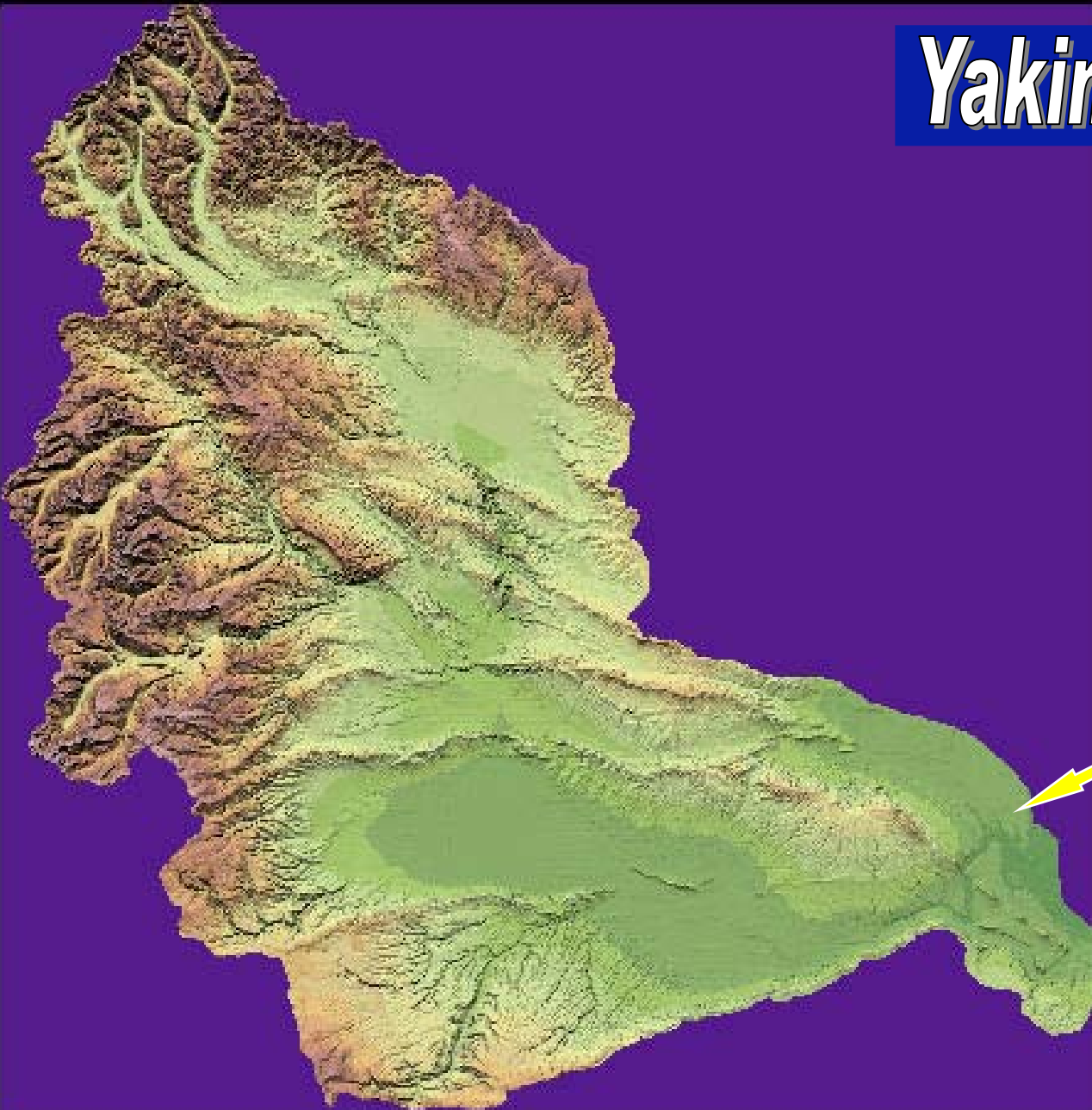
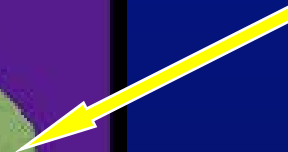


Image produced from a
Digital Elevation Model
(DEM) with a cell width
of 208 feet (1 acre)



Yakima River Basin Numbers

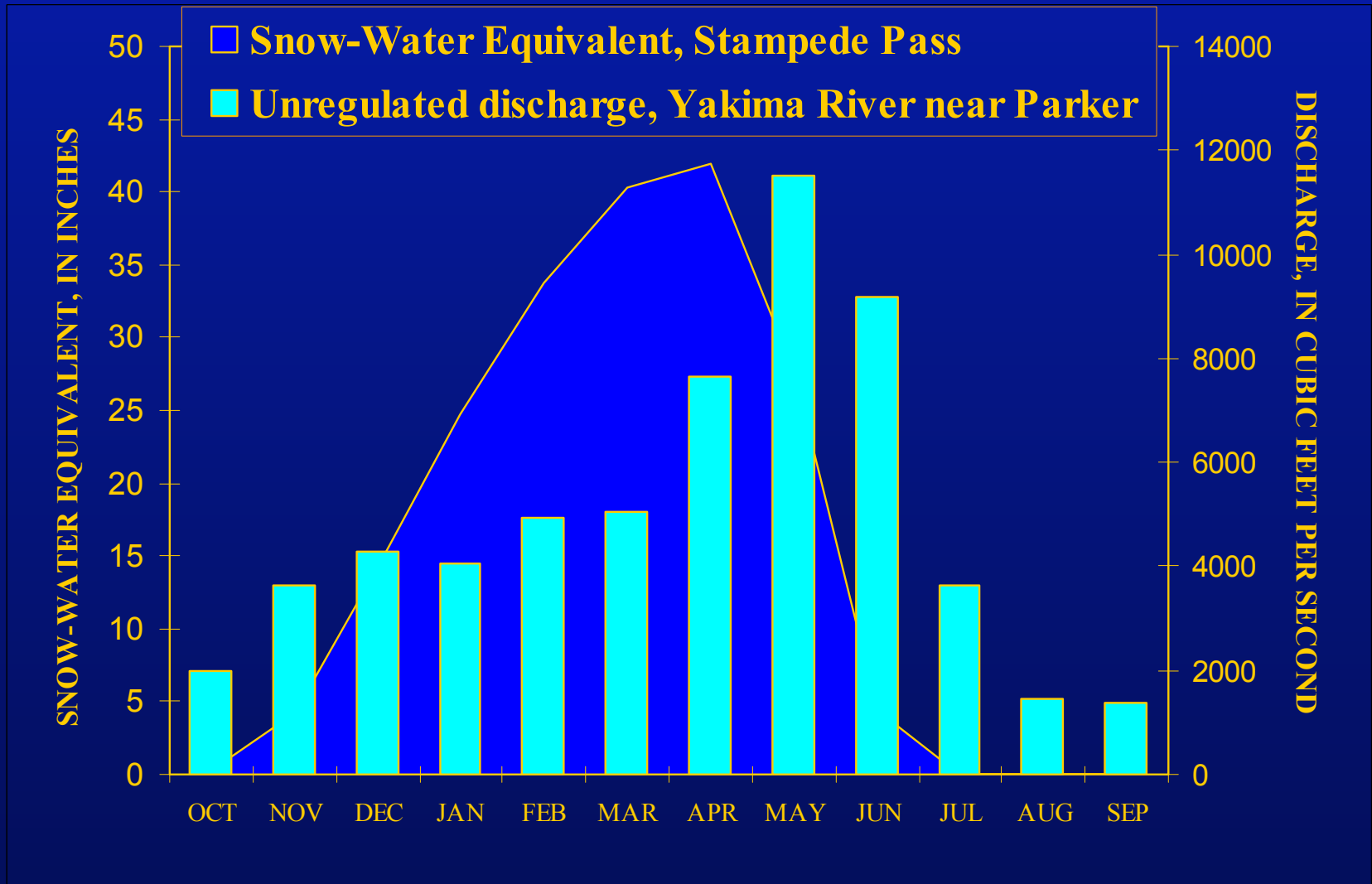
Miscellaneous

- Drainage area is 6,200 sq. miles
- Elevation ranges from 400 to 8,000 ft.
- Precipitation varies from 6 to 90 inches per year
- About 45% of water diverted for irrigation becomes return flow
- During low-flow season, about 75% of the streamflow is return flow

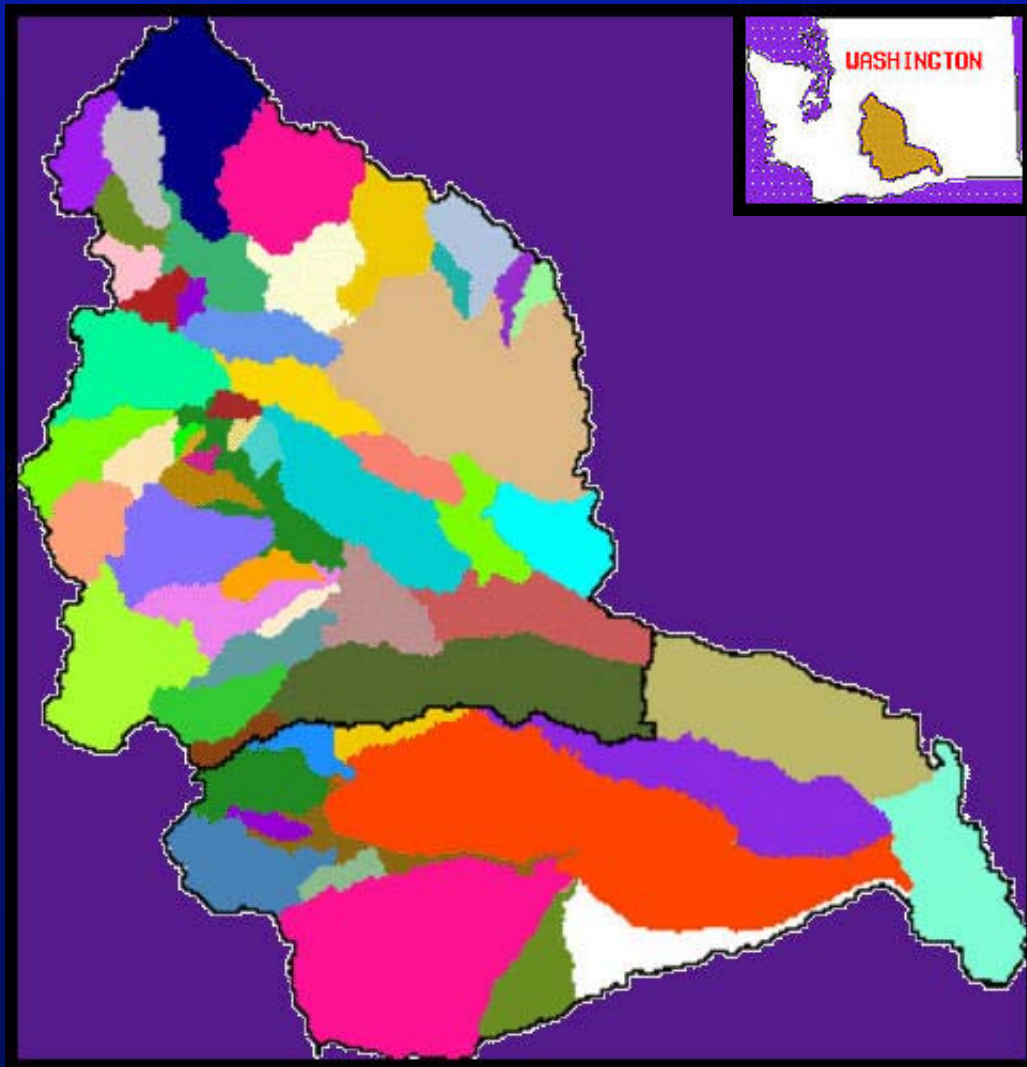
Water Balance

Ave. Precip. (27 inches)	= 8.7 million ac-ft	12,000 cfs
Unregulated Runoff	= 4.0 million ac-ft	5,600 cfs
Regulated Runoff	= 2.6 million ac-ft	3,600 cfs
Water Demand	= 2.5 million ac-ft	63% of unregulated runoff
Storage	= 1.1 million ac-ft	26% of unregulated runoff

Snowpack and Streamflow Characteristics



Subbasin divisions used in the Yakima WARSMMP project



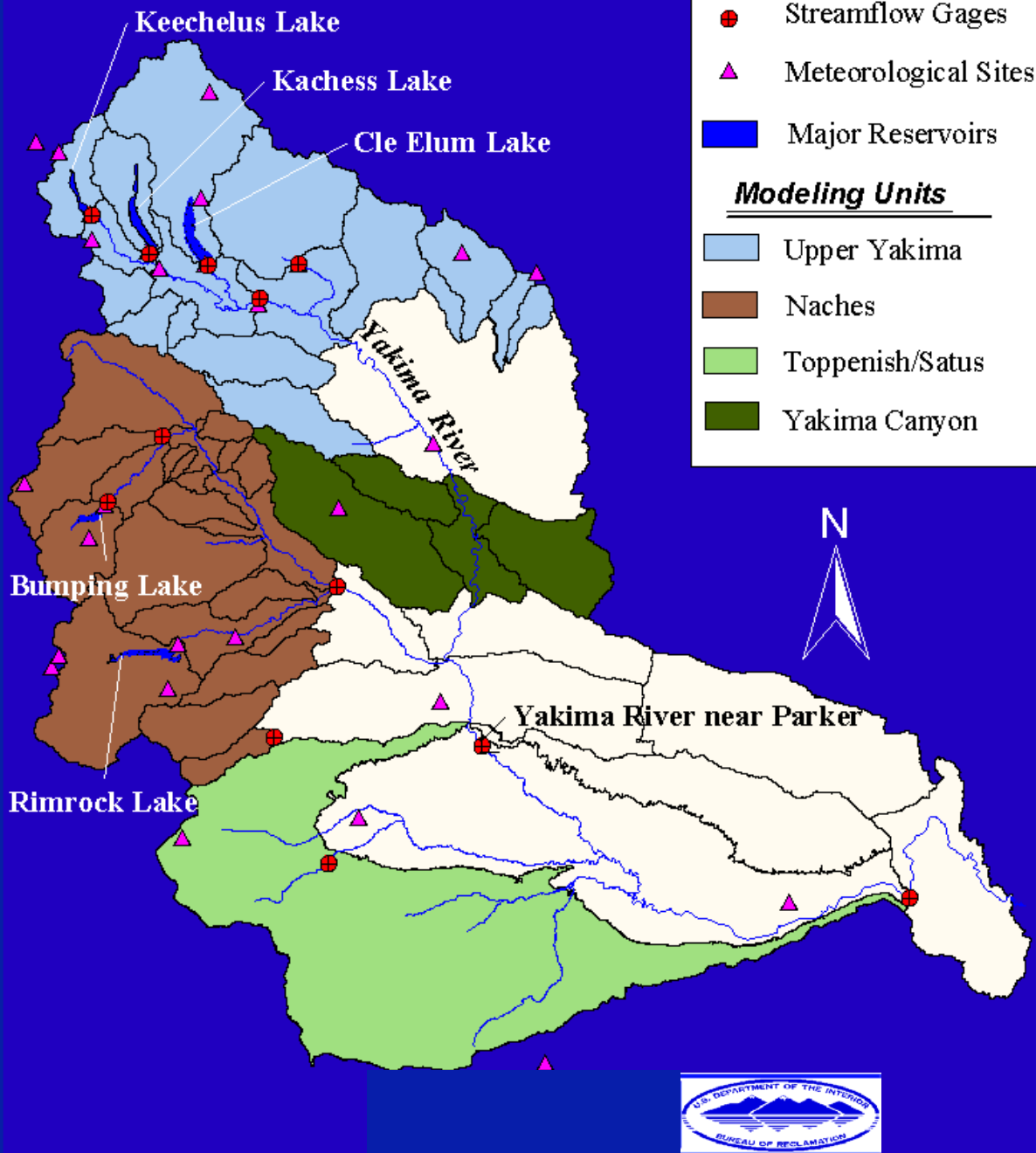
The GIS Weasel was used
to delineate 59 subbasins

- finer definition in the headwater regions
- coarser definition in the lowland, agricultural regions

Modeling Units

About 95 % of the streamflow at Yakima River near Parker is generated from four modeling units:

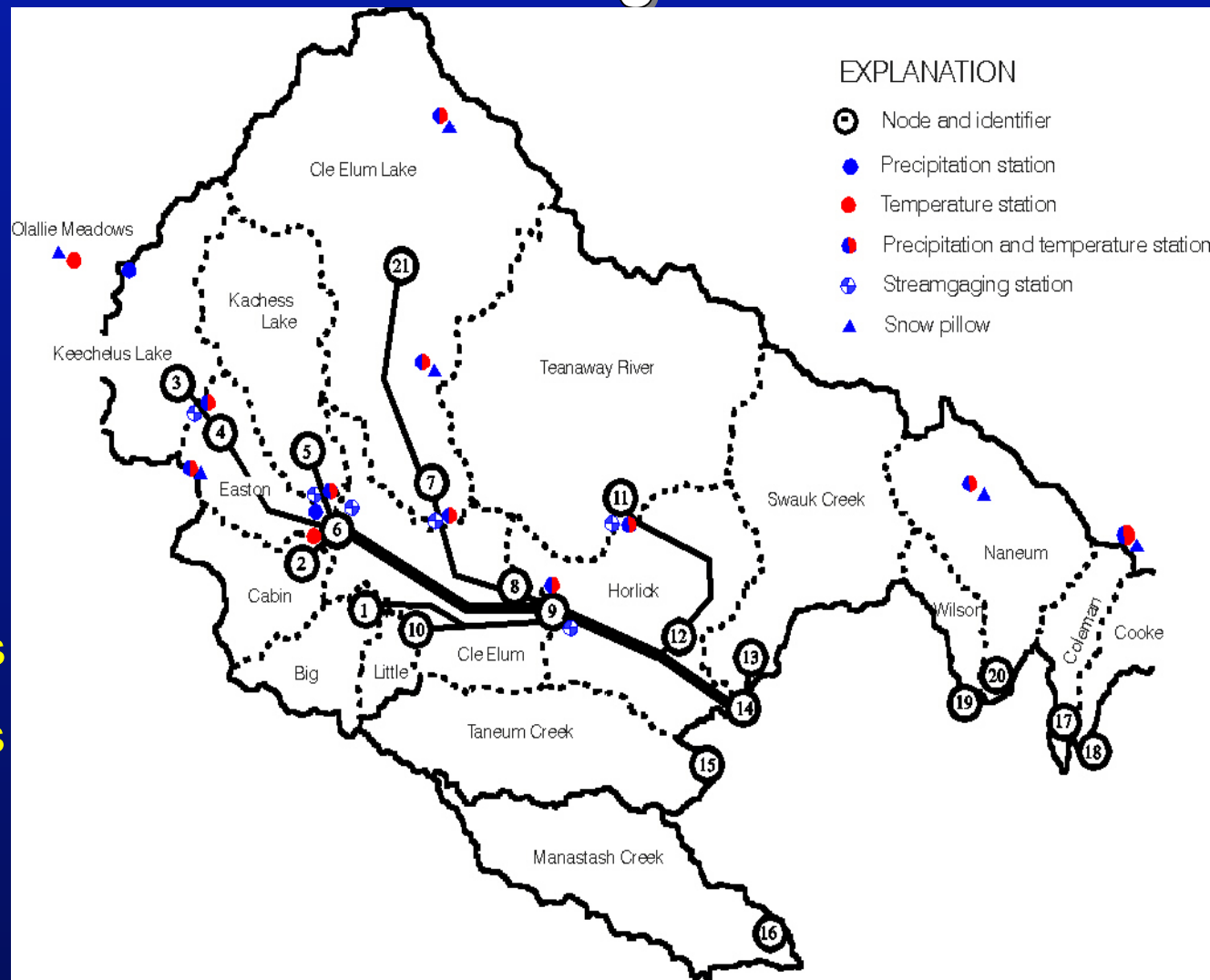
- Upper Yakima
- Naches
- Toppenish/Satus
- Yakima Canyon



Upper Yakima Modeling Unit

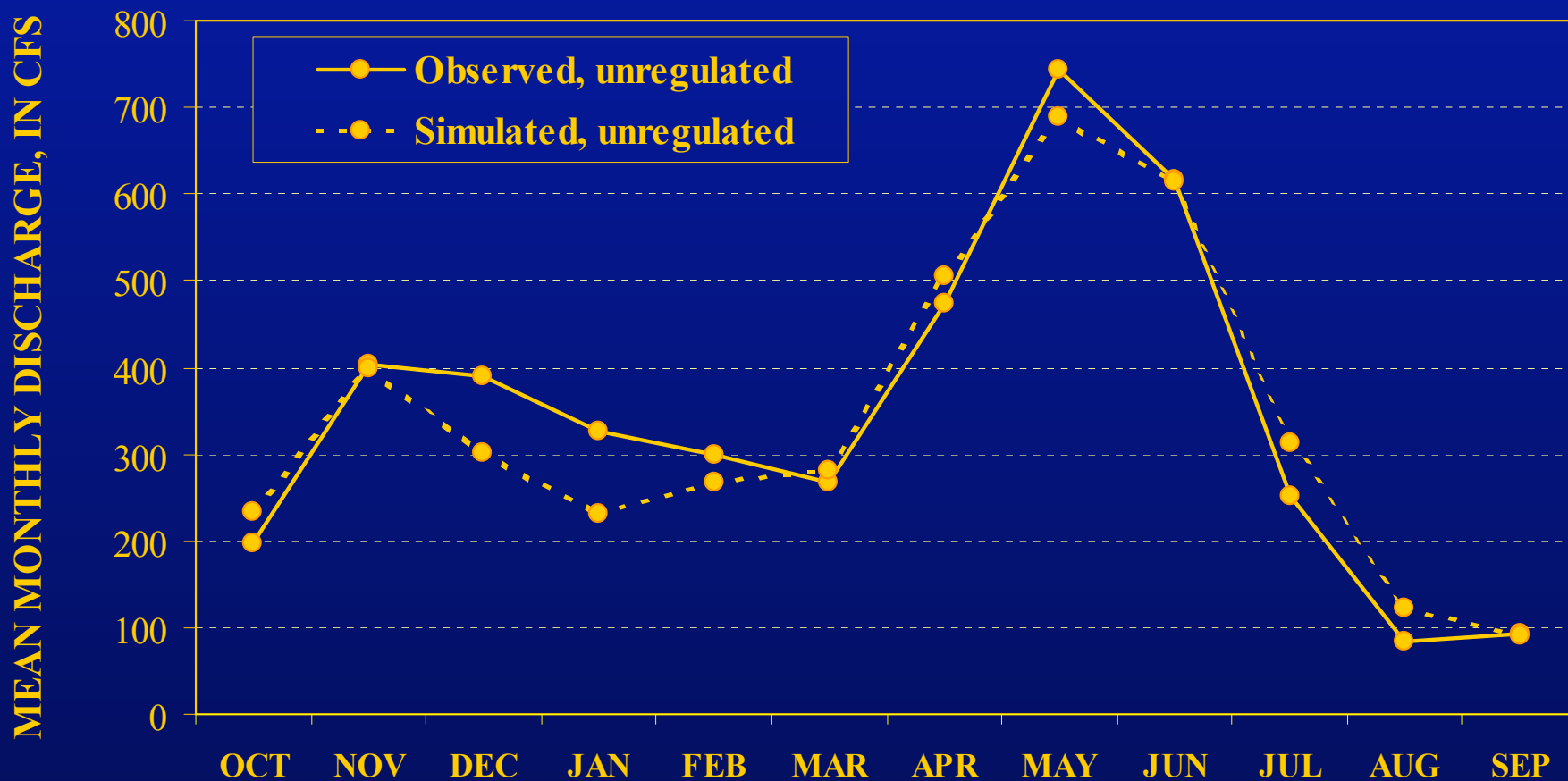
Upper Yakima Modeling Unit

- 404 MRUs
- 17 subbasins
- 21 nodes
- 14 precipitation inputs
- 13 temperature inputs



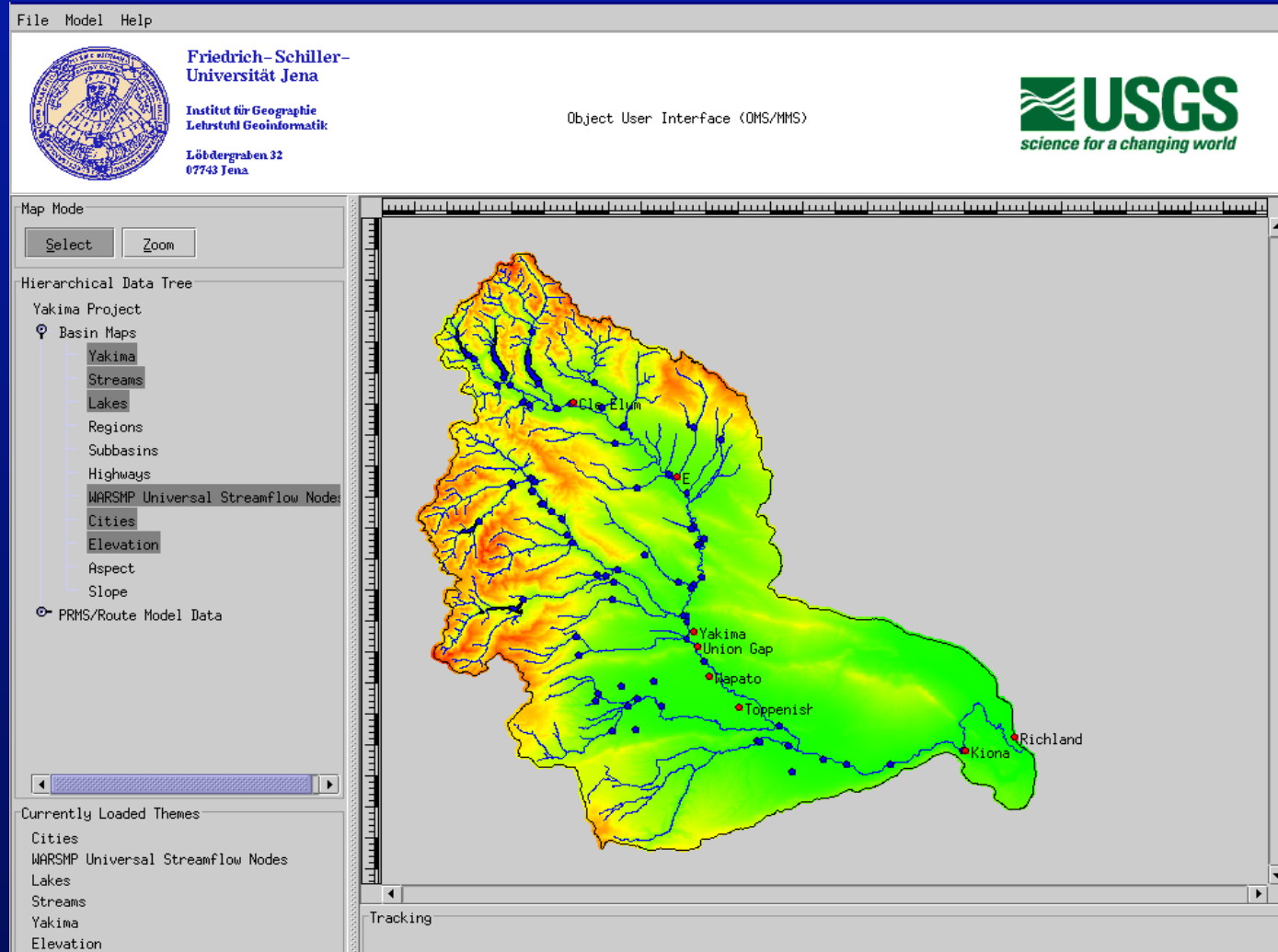
Comparison of Observed and Simulated Streamflow

Mean Monthly Unregulated Discharge for Keechelus Lake Outflow

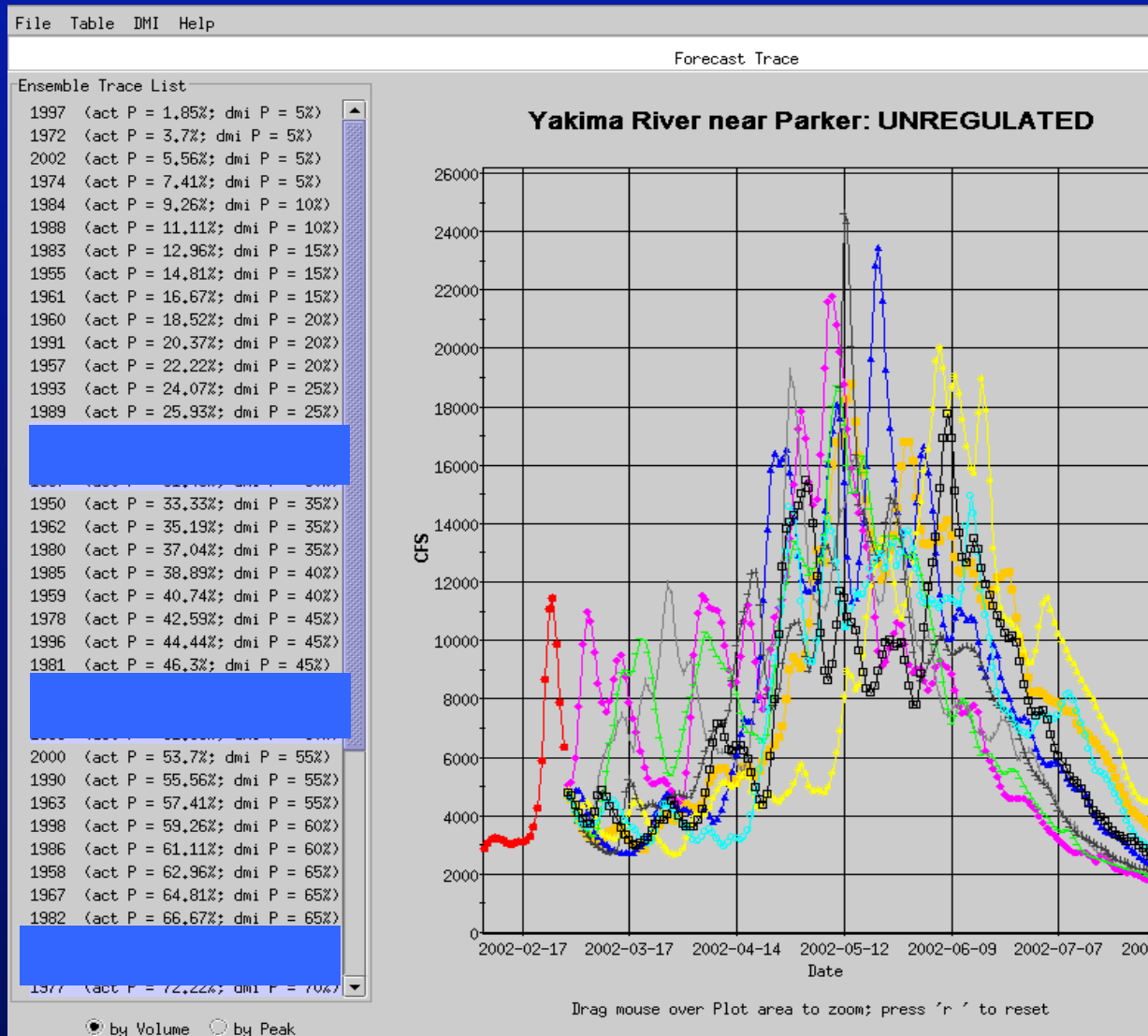


MMS Application--Object User Interface

XML interface links to HDB and runs watershed models



ESP--Ensemble Streamflow Prediction



Built-in utility to
forecast runoff
volumes

- Forecast made on March 1 for Yakima R. nr. Parker
- Forecast traces arranged by exceedance probability
- 50% exceedance is the “most probable” runoff volume

Yakima River DSS

- Provides a flexible, toolbox approach to system development
- Provides simulated unregulated streamflow at many locations throughout the basin (MMS).
- Facilitates analysis of complex water problems with built-in rules for water storage and diversions (RiverWare).
- Provides a framework for multi-disciplinary research and operational applications by linking watershed and water-management models (OUI and HDB).
 - Long-term—water-management planning and policy based on 53-years of flow/climate data
 - Mid-term-- ESP for 6-month to 1-year forecasting
 - Short-term--water management for day-to-day operations

More Information

<http://www.usbr.gov/warsmp>

<http://wwwbrr.cr.usgs.gov/mms>

<http://cadswes.colorado.edu/riverware>

<http://wa.water.usgs.gov/warsmp/warsmp/html>

